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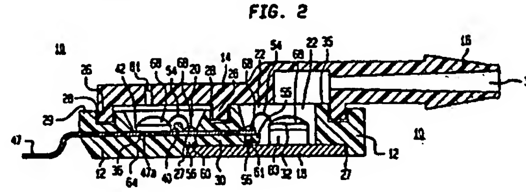
(54) Pressure sensor and method of fabrication thereof.

(57) A pressure sensor (10) includes a three part package including a main housing member (12) defining two spaced-apart chambers (20,22), a bottom closure member (18) providing the bottom wall of one of the chambers, and a top cover member (14) hermetically sealing the two chambers from one another and including a port (34) for admission of gases into one of the chambers. A pressure sensing element (32) is disposed in the chamber having the port and mounted on the bottom closure member, and a signal processing element (36) is mounted in the other chamber. Electrical connections between the two elements are by means of leads (47) which extend into each chamber and pass through an inner wall (30) separating the chambers. A low temperature differential between the two elements is provided by extending (47a) one of the leads from the one chamber to a position directly underlying and in intimate contact with the bottom surface of the signal processing element in the other chamber.
Additionally, the bottom closure member is of a high thermal conductivity material and extends along the bottom of the main housing member to beneath the other chamber.

FIG. 2



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PRESSURE SENSOR AND METHOD OF FABRICATION THEREOF

This invention relates to pressure sensors of the type using separate pressure sensing and electrical signal processing elements, and particularly to the packaging and fabrication of such sensors.

Pressure sensors are used in automotive vehicles for a variety of purposes, for example, sensing the vacuum pressure at the intake manifold of a vehicle engine.

One known type of pressure sensor, described in an article by Oakes which appears in the proceedings of the Third International Conference on Automotive Electronic, 143-9, 1981, and is entitled "A Pressure Sensor for Automotive Application", Mechanical Engineering Publications, London, England, page 354, ISBN 085298 477 4, comprises a pressure sensing element, including a piezoresistive silicon semiconductor chip, and a separate semiconductor integrated circuit (IC) for receiving an electrical signal from the sensing element, processing the signal, and generating the output signal from the pressure sensor. In this known pressure sensor, the pressure sensing element is completely enclosed in its own sub-package which includes outwardly extending terminals permitting electrical access to the enclosed sensing element. The sub-package is entirely enclosed, in turn, in the main package of the pressure sensor. The main package includes a port which communicates directly with an opening in the pressure sensing element sub-package permitting exposure of the pressure sensing element to the pressure to be sensed.

The signal processing IC is also mounted within the package main housing and electrically connected to the terminals of the pressure sensing element sub-package by wire bonds. Finally, wire bonds interconnect terminal portions of the signal processing IC to terminals of the main package.

It is desirable to improve such known pressure sensor in four principal areas, namely: the differential operating temperature between the pressure sensing element and the signal processing element, size, simplicity of construction and fabrication, and cost.

To this end, a pressure sensor in accordance with the present invention is characterised over the above mentioned prior art by the feature specified in the characterising portion of Claim 1.

In one illustrative embodiment, the present invention is directed to a pressure sensor comprising two chambers which are hermetically sealed one from the other with the first chamber containing a pressure sensing element and the second chamber containing a signal processing element. Electrical interconnections couple the two elements. A portion of the pressure sensor defines a port or opening which couples the first chamber to a pressure to be sensed. The pressure sensor further comprises a relatively high thermal conductivity member having a portion thereof that thermally contacts a substantial portion of the signal processing element and having another portion thereof that extends into the first chamber such that any temperature differential between the two chambers is moderated.

In accordance with this invention, the aforementioned desired improvements are achieved as follows. The enclosure or package for the pressure sensor comprises two separate chambers which are hermetically sealed from one another. The pressure sensing element is disposed within one of the chambers and a port is coupled to that chamber to permit exposure of the sensing element to the pressure to be sensed. A signal processing element is disposed within the other chamber. Electrical interconnections between the two elements are by means of conductive leads which extend, in hermetic fit, through an inner wall separating the two chambers.

Temperature differentials between the pressure sensing and signal processing elements tend to introduce errors in the pressure sensing process. To moderate such temperature differentials, thermally and electrically conductive members (leads) are provided for closely thermally coupling together the two chambers and the respective elements therein. One such member comprises one of the interconnecting electrical leads which is disposed along the bottom surface of the chamber containing the signal processing element. A bottom surface of the signal processing element is mounted directly on an enlarged portion of the the lead in good thermal relation therewith. The lead extends through the inner wall separating the chambers and directly into the chamber containing the pressure sensing element. Heat from the pressure sensing element chamber is thus conducted directly by the lead and into direct contact with the signal processing element. Other electrical leads which communicate between the pressure sensing and signal processing elements also serve to moderate temperature differentials between the two elements. Another such thermally conducting member comprises a separate base portion (bottom closure member) of the package which is formed from a material, e.g., a metal, which is more highly thermally conductive than other portions of the package. This base portion forms the bottom wall of the pressure sensing element chamber and extends beneath the inner wall separating the two chambers

and directly beneath, and in intimate thermal connection with the bottom wall forming the bottom of the other chamber. Heat from the pressure sensing chamber is thus transferred, via the bottom closure member, to the signal processing element chamber through the bottom wall thereof.

The pressure sensor is designed to allow the chamber containing the pressure sensor element to be pressurized to a test pressure while the other chamber is left open such that the signal processing element can be tested and modified as desired.

The present invention will now be described, by way of example, with reference to the following detailed description taken in conjunction with the accompanying drawings, in which:-

Figure 1 is a plan view, partly broken away, of a pressure sensor in accordance with this invention;

Figure 2 is a sectional view of the pressure sensor shown in Figure 1 taken along line 2-2 thereof;

Figure 3 is a view, in perspective, of one portion of a three-part package or enclosure for the pressure sensor shown in Figures 1 and 2; and

Figure 4 is a view, in side section, showing a step in the fabrication of the pressure sensor.

With reference to Figures 1 and 2, there is shown a pressure sensor 10 (also denoted as a pressure sensor assembly 10) in accordance with this invention. Figure 2 shows a cross sectional view of Figure 1 along dashed line 2-2. The pressure sensor 10 comprises a three-part package which includes a main housing member 12, a top cover member 14, which includes a port member 16 and an air vent hole 81, and a bottom closure member 18. The main housing member 12 and the top cover member 14 are preferably made of a known thermoplastic resin, and the bottom closure member 18 is preferably formed of a high thermally conductive material, e.g., a metal such as aluminium, or a high thermally conductive ceramic. To provide an hermetic fit between the top cover member 14 and the main housing member 12, a tongue-in-groove joint is used, the tongue portion 26 of the joint (Figure 2) being dependent from the top cover member 14, and the groove portion 28 being provided in the main housing member 12. A recess 27 is provided in the bottom surface of the main housing member 12 for receipt of the bottom closure member 18.

The pressure sensor 10 contains two spaced-apart chambers 20 and 22. The package walls defining the chambers 20, 22 include an outer wall 29 of the main housing member 12 and an inner wall 30 bisecting the main housing member 12 and hermetically separating the two chambers 20 and 22.

As best seen in Figure 3, which is a view in perspective of the main housing member 12 of pressure sensor assembly 10 by itself, the groove portion 28, which forms part of the tongue-in-groove joint with the top cover member 18 (Figure 2), is formed in the top surfaces of the outer and inner walls 29 and 30. The inside wall of the groove portion 28 defines two wall or lip portions 31 and 33, the lip portion 31 forming part of the wall defining the chamber 22 and the lip portion 33 forming part of the wall defining the chamber 20. As best seen in Figure 4, which is a view of the pressure sensor 10 without its top cover member 14, the lip portion 31 around the chamber 22 forms a cylinder which projects beyond the upper surface of other portions of the two walls 29 and 30. The upper end of the lip portion (or cylinder) 31 terminates in an annular surface 35 (Figure 3). The purpose of these structural details is described hereinafter.

Returning to Figures 1 and 2, disposed within the chamber 22 is a pressure sensing element 32 of known type, e.g., a silicon semiconductor chip of the type described in the aforementioned Oakes article. The chamber 22 communicates with a port or opening 34 through the port member 16 for the admission of the pressure to be sensed by the pressure sensing element 32 disposed within the chamber 22.

Disposed within the other chamber 20 is a semiconductor integrated circuit (IC) chip of known type referred to as a signal conditioning or processing element 36. As known, the purpose of the signal processing element 36 is to receive an electrical signal from an electrical circuit (e.g., a Wheatstone bridge circuit -not shown) on the pressure sensing element 32 and process it (e.g., provide temperature compensation and signal amplification) to produce an output signal from the pressure sensor 10.

Included within the chamber 20 is a low wall 40 having sloped sides which extends parallel to the inner wall 30 separating the two chambers 20 and 22. This low wall 40, along with the outer wall 29 (which also has sloped sides within the chamber 20), defines a recess 42 (typically rectangular - see, also, Figure 3) within the chamber 20 for receipt of the signal processing element 36.

The pressure sensing and signal processing elements 32 and 36 are interconnected to one another and to terminal leads of the pressure sensor 10 as follows. Partially embedded within the material of the main housing member 12 are a number of conductive leads 46 through 50. With reference to Figure 1, various portions of each of the leads 46-50 are exposed within each of the two chambers 20 and 22. Also, three of the leads 46, 47, and 48 extend outwardly from one end of the

main housing member 12 and serve as exterior terminals for the pressure sensor 10. Other leads, not shown, can be provided extending from the other end of the main housing member to serve as means for mechanically supporting the pressure sensor, e.g., within a socket of known type, not shown.

The paths of the various leads 46-50 are shown, partially in dashed lines where the leads are embedded within the main housing member 12, in Figure 1. Thus, starting with the two outer terminal leads 46 and 48, these leads extend into the main housing member 12 and pass, still embedded wtihin the housing member material, on either side of the chamber 20. The two leads 46 and 48 then emerge (Figure 1) within the chamber 20 in the space between the low wall 40 within the chamber 20 and the inner wall 30 separating the two chambers 20 and 22. The lead 46 continues through the inner wall 30 and emerges, exposed, within the chamber 22. The other lead 48 also continues into the inner wall 30 but terminates there.

The third, central terminal lead 47 extends into the main housing member 12 and directly into the chamber 20 (see also Figure 3). Within the chamber 20, the width of the lead 47 expands in an enlarged portion 47a thereof to completely cover the bottom surface of the recess 42. (The edges of the enlarged portion 47a extend beneath the recess walls, hence the edges are shown in dashed lines in Figure 1). Beyond the recess 42, the lead 47 narrows in width, passes (Figure 2) under the low wall 40, and becomes exposed again in the space between the low wall 40 and inner wall 30. The lead 47 then passes through the inner wall 30 and emerges within the chamber 22. As shown in Figure 1, the various leads which pass through the inner wall 30 follow a zigzag path for better utilization of the package space.

Two more leads 49 and 50 (see Figures 1 and 3) are provided. These leads 49, 50 start, exposed, on the bottom surface of the chamber 20 in the space between the low wall 40 and inner wall 30, pass through the inner wall 30, and emerge within the chamber 22.

Electrical interconnections between the pressure sensing and signal processing elements 32 and 36 and the various leads 46-50, and thus to each other and the sensor terminals 46, 47, and 48, are by means of wire bonds 54 (Figure 2).

As noted, each of the leads 46, 47, 49, and 50 extends into the chamber 22. As shown in Figure 3, and by the type of cross-hatching used in Figure 2, the spaces between the leads are filled with thin layers or webs 52 of the material of the main housing member 12. Also, suspended both from the webs 52 and the leads 46-50 at a position adjacent to the forward ends of the leads within the chamber 22 is a bar 55 of the material of the main housing member 12. The combination of the continuous surface formed by the alternating leads and webs, and the dependent bar 55 forms a trough 61 (Figure 2) which is preferably filled with a known protective or passivating substance 56 for hermetically sealing the exposed joints between the inner wall 30 and the emerging leads. This is known as "backside passivation" of the leads. A silicon adhesive can be used as a passivating substance.

Similarly, to provide backside passivation of the various leads where they first enter the inner wall 30 from the chamber 20, a trench 60 is provided through a bottom wall 64 of the chamber 20. To avoid excessive complication of the drawings, the trench (trough) 60 is not shown in Figure 1. However, the trench 60 extends beneath the space between the low and inner walls 40 and 30 a distance sufficient to fully expose the undersides of all the leads 46-50 where they extend into (and thus form joints with) the inner wall 30. This trench 60 is also filled with the passivating substance 56.

As previously noted, a function of the signal processing element 36 (within the chamber 20) is to process the electrical signal from the pressure sensing element 32. It is a known characteristic of such signal processing elements 36 that the output signal therefrom is a function (among other things) of the temperature differential between the signal processing and pressure sensing elements. However, the temperature of the gases admitted into the (pressure sensing) chamber 20 during use of the pressure sensor 10 is variable. This can give rise to a variable temperature differential between the pressure sensing and signal processing elements 32, 36 which, in turn, can cause errors in the output signal of the pressure sensor 10.

In accordance with this invention, means are provided for reducing any temperature differential between the signal processing and pressure sensing elements 36 and 32.

In a preferred embodiment of the invention, a first means for reducing temperature differentials between pressure sensing and signal processing elements 32 and 36 comprises electrical lead 47 which enters chamber 20 and runs under signal processing element 36 and makes good thermal contact therewith. The portion of lead 47, shown as portion 47a, which is under a bottom surface of signal processing element 36, is enlarged and typically has an area greater than the foot print of signal processing element 36. Lead 47 passes through inner wall 30 and enters chamber 22. Another bonding lead 54 is bonded by one end to lead 47 where it enters chamber 22 and is bonded by a second end to a bonding pad on a top surface of pressure sensing element 32. The physical

shape of lead 47 and its location facilitates a good transfer of heat to signal processing element 36 from chamber 22 and pressure sensing element 32. This helps moderate any temperature differentials between pressure sensing and signal processing elements 32 and 36. In this embodiment lead 47 is essentially electrically isolated from the bottom of signal processing element 36 and a bonding lead 54 makes electrical contact between a bonding pad on a top surface of signal processing element 36 and a portion of lead 47. In some applications it is feasible that enlarged portion 47a of lead 47 could make both thermal and electrical contact to the bottom surface of signal processing element 36.

A second means for reducing temperature differentials between pressure sensing and signal processing elements 32 and 36 comprises the various leads 46, 49, and 50 which extend between and into both chambers.

A third means for reducing temperature differentials between pressure sensing and signal processing elements 32 and 36 comprises the bottom closure member 18 (Figure 2) which, as previously mentioned, is preferably made of a high thermal conductive material and which extends from beneath the chamber 22 to beneath the chamber 20. In use of the pressure sensor 10, hot gases admitted into the chamber 22 heat the bottom closure member 18 which conducts, with little temperature drop, heat energy from the chamber 22 to the bottom wall 64 of the chamber 20. As shown, the portion of the bottom wall 64, which directly overlies the bottom closure member 18, is of reduced thickness (by the thickness of the bottom closure member 18), and heat from the bottom closure member 18 is conducted through the bottom wall 64 to the enlarged portion 47a of the lead 47. This enlarged portion 47a, which as previously described, underlies the entire bottom surface of the signal processing element 36 (see Figure 1), provides an excellent path for heat conduction to the signal processing element 36.

It is estimated that with a temperature range of from -40 degrees C. to +125 degrees C. for the gases admitted into the chamber 22, the temperature differential between the pressure sensing and signal processing elements 32 and 36 should be approximately 5 degrees C. A temperature differential of up to approximately 15 degrees C. is useful. This is small enough so as not to introduce unacceptably high errors in the output readings from the pressure sensor 10.

In a typical embodiment of pressure sensor 10, the main housing member 12 and the top cover member 14 are formed from a thermoplastic resin and are fabricated using known moulding techniques. In the case of the main housing member 12, the various leads are first formed as part of a stamped or etched sheet of metal held together by a peripheral frame. This sheet, known as a lead frame, is placed within a mould, and the thermoplastic resin is forced into the mould to form the main housing member 12 around the various leads. Upon opening of the mould and removal of the workpiece, the frame peripheral members, which are not embedded within the material of the main housing member 12, are broken away to electrically isolate the various leads 46-50 from one another. The remaining package part, i.e., the bottom closure member 18, is preferably formed by a stamping process.

A preferred embodiment of pressure sensor 10 is assembled as follows: A pressure sensing element 32 of the type shown in the aforementioned Oakes article is used. Briefly, the pressure sensing element 32 comprises a disc of semiconducting material, e.g., silicon, having a recess therein forming a pressure sensitive diaphragm. A simple Wheatstone bridge circuit is formed within the silicon disc by appropriate doping techniques, and terminal pads are provided on the disc by means of which electrical interconnections can be made thereto. The disc is electrostatically bonded to a block of borosilicate glass 83, for purposes of stress isolation, and the glass block, in turn, is mounted and glued to a top surface of the bottom closure member 18. Passivating substance 56 is then put into troughs 60 and 61 and then bottom closure member 18 is adhesively attached (i.e., glued) to main housing member 12 to close the bottom of chamber 22 and to form a hermetic seal. Additional amounts of passivating substance 56 are placed in recess 27. For the sake of simplicity the drawings do not show passivating substance 56 in recess 27.

The signal processing element 36 is then glued in place within the recess 42 formed within the chamber 20. Proper positioning of the signal processing element 36 within the recess 42 is simplified by the sloped sides of the recess defining outer and low walls 29 and 40. Also, a known high thermal conductive adhesive is preferably used to provide an intimate and good thermal conducting interface between the bottom surface of the signal processing element 36 and the enlarged portion 47a at the bottom of the recess.

The wire bonds 54 are then made between various terminal pads on each of the signal processing and pressure sensing elements 36, 32 and the exposed surface portions of the leads 46-50 in each of the respective chambers 20 and 22. A known protective coating 68 (Figure 2) is then applied over the pressure sensing element 32 to protect it against any hostile environment, e.g., automotive engine gases, which it will encounter in-

use. The protective coating is also applied over the exposed surface portions of the leads 46-50 including the ends of the wire bonds 54 bonded thereto to protect against any hostile environment and to help hermetically seal chamber 22 where the electrical leads enter same from chamber 20. In an illustrative embodiment protective coating 68 is a long chain polymer.

At this point in the assembly of the pressure sensor 10, the electrical parameters of the signal processing element 36 are evaluated and adjusted as necessary. To this end, a test pressure applying means, known as a boot 70 (Figure 4), is applied against the annular surface 35 of the (upwardly extending) lip portion 31 surrounding the chamber 22, and a test pressure or vacuum is applied to the chamber 22 via the boot. To provide an hermetic seal between the boot 70 and the lip portion 31, a rubber gasket 71 is provided at the end of the boot. Because the lip portion 31 extends higher than other wall portions of the main housing member 12, as previously described, the rubber gasket 71, when squeezed between the boot 70 and annular surface 35, is free to deform downwardly and around the lip portion. This, it is found, ensures an hermetic fit between the boot 70 and the chamber 22.

With the boot 70 in place and a pressure applied to the chamber 22, the package is tested, using known procedures, for leaks between the two chambers 20 and 22. If there are no leaks, the next step, with the boot 70 in place and a known pressure applied to the pressure sensing element 32, is to measure the electrical parameters of the signal processing element 36. Then, as necessary, adjustments (i.e., the trimming of resistors) are made to the signal processing element 36 to adjust its parameters to provide a preselected output signal consistent with the test pressure.

A feature of the package of this invention is that the provision of the two separate chambers 20 and 22 allows the enclosure of the chamber 22 by the boot 70 while leaving the chamber 20 and the signal processing element 36 therein fully uncovered. This allows unencumbered access to and direct contacting of the signal processing element 36 by means of electrical probes 72, or the like, for measuring the electrical parameters of the signal processing element 36. Then, using known techniques, these parameters are adjusted as necessary. For example, different ones of the electrical probes 72 can be used to send currents through selected current paths for burning open these paths, thereby selectively altering the electrical characteristics of the element circuits. Alternatively, and particularly because of the direct access to the signal processing element 36 surface, a laser beam can be used to bum open selective portions of the circuitry to make the desired adjustments.

After completion of the testing and adjusting procedures, the boot 70 is removed and a protective coating 68 (Figure 2) is applied over the signal processing element 36 and over the portions of the electrical leads 46-50 and wire bonds 54 where the electrical leads enter inner wall 30. The pressure sensor 10 is completed by the addition of the top cover member 14. The top cover member 14 is hermetically sealed to the main housing member 12 by means of an adhesive which is dispensed into the groove portion 28 surrounding the chambers 20 and 22. Air vent hole 81 in top cover member 14 serves to allow any air in the adhesive used in the portion of groove portion 28 surrounding chamber 20, which might escape into chamber 20, to be vented out. Thus helps eliminate any build up of pressure in chamber 20 which could cause a break in hermetic seal between chambers 20 and 22.

It is to be appreciated that various modifications may be made to the pressure sensor without departing from the spirit of the invention. For example, the bottom closure member 18 could extend further across the bottom of chamber 20 to further increase the thermal equalization desired between the signal processing and pressure sensing elements 36,32. Still further, the outside geometry of pressure sensor 10 can readily be modified to permit use of pressure sensor 10 in different mounting arrangements. Furthermore, top cover member 14 can be replaced with two separate portions. The first portion would cover chamber 20 and the second portion would cover chamber 22. Still further, in some applications bottom closure member 18 can be of the same material as main housing member 12.

Claims

1. A pressure sensor (10) comprising: a package defining two chambers (20,22); a pressure sensing element (32) disposed in a first (22) of said chambers, and a signal processing element (36) disposed in a second (20) of said chambers; means (46-50) for electrically interconnecting the pressure sensing and signal processing elements; and a port (34) which couples the first chamber (22) to a pressure to be sensed; characterised in that the two chambers (20,22) are hermetically sealed from one another; and by temperature reducing means for reducing any temperature differential between the two chambers (20,22) comprising a relatively high thermal conductivity member (46-50) having a portion (47a) thereof that thermally contacts a substantial portion of the signal processing element (36) disposed in the second

chamber (20) and has a portion thereof that extends into the first chamber (22) such that any temperature differential between the two chambers is moderated.

2. A pressure sensor as claimed in claim 1, wherein the temperature reducing means comprises a plurality of electrical leads (46-50) which communicate with both chambers (20,22).

3. A pressure sensor as claimed in claim 2, wherein one or more of the electrical leads (46-50) electrically interconnects the pressure sensing and signal processing elements (32,36).

4. A pressure sensor as claimed in claim 2 or claim 3, wherein the high thermal conductivity member is an enlarged portion (47a) of at least one (47) of said electrical leads (46-50) that thermally contacts a substantial portion of the signal processing element (36).

5. A pressure sensor as claimed in any one of claims 1 to 4, further comprising a second relatively high thermal conductivity member (18) which communicates with both chambers.

6. A pressure sensor as claimed in any one of claims 1 to 5, wherein the package comprises a main housing member (12) having integral therewith an outer wall (29) and an inner wall (30) which define the two chambers (20,22) which are separated from each other by the inner wall.

7. A pressure sensor as claimed in claim 6 comprising electrical leads (46-50), wherein the electrical leads extend through the inner wall (30) and are exposed within each of the chambers (20,22); and wherein wire bonds (54) interconnect terminals on each of the pressure sensing and signal processing elements (32,36) to different electrical leads.

8. A pressure sensor as claimed in claim 7, further comprising a second wall (40) extending upward from the bottom surface of the second chamber (20) and spaced from the inner wall (30), the second wall defining a recess (42) within the second chamber (20) for receipt of the signal processing element (36).

9. A pressure sensor as claimed in claim 8, wherein the recess (42) is defined, in addition, by lip portions (33) of the package which enclose the second chamber (20), the lip portions (33) and the second wall (40) having inwardly sloped sides providing guide means for proper positioning of the signal processing element (36) therein.

10. A pressure sensor as claimed in claim 8 or claim 9 comprising an electrical lead (47) with an enlarged portion (47a), wherein the enlarged portion (47a) completely covers the bottom surface of the recess (42), the signal processing element (36) being bonded, in intimate thermal contact with the enlarged portion.

11. A pressure sensor as claimed in any one of claims 6 to 10, wherein the package further comprises a bottom closure member (18) of a material having a higher thermal conductivity than that of a material of the main housing member (12), the bottom closure member (18) forming the bottom wall of the first chamber (22) and extending beneath the inner wall (30) and to a position underlying the second chamber (20) and forming a high thermal conductivity path for heat transfer from the first chamber to the signal processing element (36).

12. A pressure sensor as claimed in any one of claims 6 to 11 having electrical leads (46-50), wherein a protective coating (68) is disposed on the electrical leads in areas of entry into and exit from the inner wall (30) for hermetically sealing the exposed joints between the leads and the first wall.

13. A method of fabricating a pressure sensor (10) comprising the steps of: disposing a pressure sensing element (32) within a first chamber (22) within a portion of a package of the pressure sensor; disposing a signal processing element (36) within a second chamber (20) within the package portion; electrically interconnecting the pressure sensing and signal processing elements; leaving the second chamber (20) and the signal processing element (36) therein unenclosed while hermetically enclosing the first chamber (22) and exposing the pressure sensing element (32) to apparatus which generates a preselected test pressure; contacting the signal processing element (36) for adjusting the electrical parameters thereof in accordance with the test pressure; removing the test pressure; and sealing a top cover member (14) to the package portion for hermetically sealing the two chambers from one another while providing a port (34) which provides access to the first chamber (22).

14. A method as claimed in claim 13 in which the hermetic enclosing step is performed using a cylindrical boot (70) with an annular sealing gasket (71) on the end thereof, and engaging the sealing gasket (71) with an annular surface (35) formed at the top of an upwardly projecting lip portion (31) defining the top, open surface of the first chamber (22), the outside edge of the sealing gasket (71) extending beyond the outside edge of the annular surface (35) and being slightly deformed by the engaging pressure, around the top wall of the lip portion (31) for providing a tight, hermetic fit between the sealing gasket (71) and the lip portion (31).

15. A method for forming a pressure sensor (10) having first and second chambers (22,20) with electrical leads (46-50) communicating between the chambers (20,22) comprising the steps of : sealing bottom and side portions of the electrical leads (46-50) so as to hermetically isolate the chambers (20-

22) from each other where the electrical leads (46-50) pass from one chamber to the other; attaching a bottom closure member (18) to a main housing member (12) of the pressure sensor (10) and forming a hermetic seal at the intersection of the bottom closure member (18) and the main housing member (12); disposing a pressure sensor element (32) within the first chamber (22) and disposing a signal processing element (36) in the second chamber (20); electrically coupling each of the signal processing and pressure sensing elements (36,32) to the electrical leads (46-50); coating a portion of the pressure sensor element (32) and coating top and side portions of the portions of the electrical leads (46-50) in the first chamber (22) with a passivating material (56); hermetically enclosing the first chamber (22) and exposing the pressure sensing element (32) to a preselected test pressure while leaving the second chamber (20) and the signal processing element (36) therein unenclosed; sensing signals from the signal processing element (36) and adjusting portions of the signal processing element such that signals received therefrom correspond to the applied test pressure; removing the test pressure from the first chamber (22); coating a portion of the signal processing element (36) and top and side portions of the portions of the electrical leads (46-50) in the second chamber; and attaching a top cover member (14) to the main housing member (12) for hermetically sealing the first chamber (22) and thus hermetically isolating the first chamber (22) from the second chamber (20), the top cover member (14) defining a port (34) which provides access to the first chamber (22).

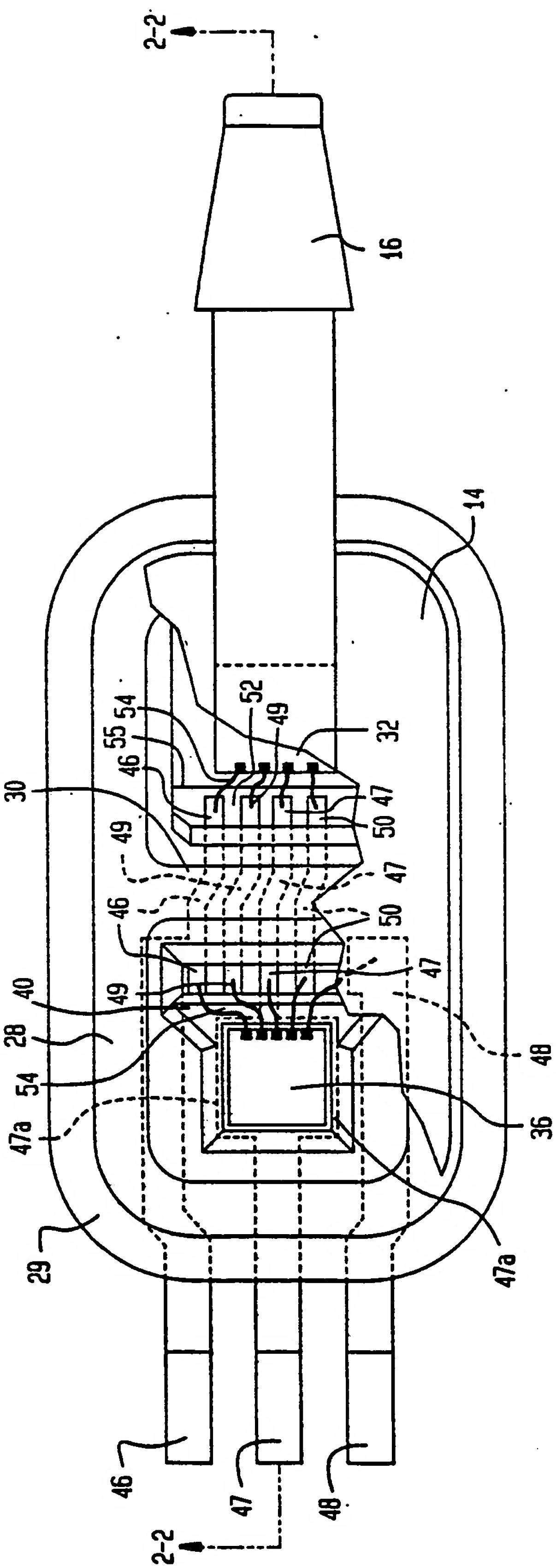
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FIG. 1

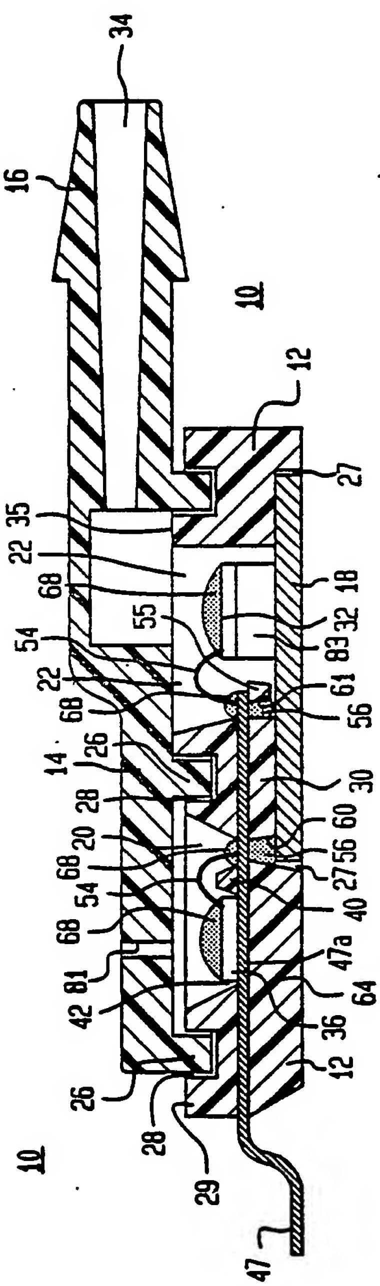

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FIG. 2

FIG. 3

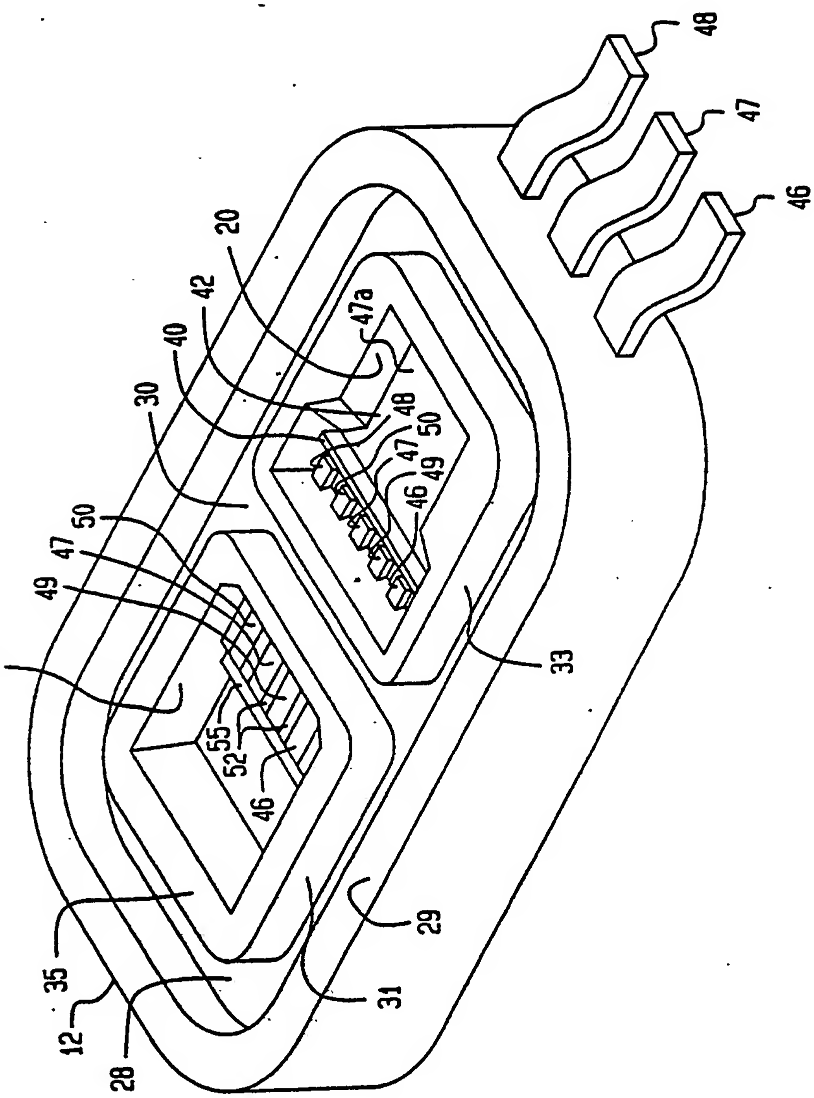
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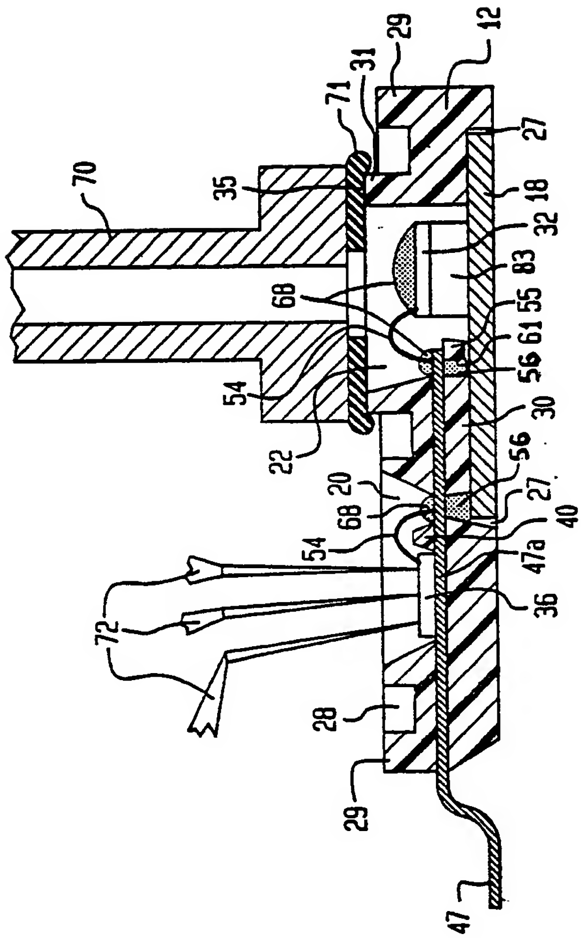
FIG. 4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